Organophosphate Pesticides: Dialkyl Phosphate Metabolites

General Information

Organophosphate pesticides account for about half of the insecticides used in the United States. Approximately 60 million pounds of organophosphate pesticides are applied to about 60 million acres of U.S. agricultural crops annually; nonagricultural uses account for about 17 million pounds per year (US EPA*a*). Organophosphate pesticides are active against a broad spectrum of insects and are used on food crops, in residential and commercial buildings, on ornamental plants and lawns, and for mosquito-vector control. Some chemicals in this class are also used in plastics manufacturing and do not have insecticidal properties.

Exposures may occur by ingestion, inhalation, or dermal contact. Ingestion of food contaminated with organophosphorus pesticides and contact during residential application are the main sources of exposure for the general population. However, farm workers, applicators, and manufacturers of these pesticides may have higher or acute exposures. The acute effects of the organophosphates from intentional and unintentional overdoses or from high-dose agricultural exposure are well known and include neurologic dysfunction that results from inhibition of acetylcholine breakdown in neural tissue. The dialkyl phosphates are metabolites of various organophosphate pesticides. The organophosphates, not the dialkyl phosphates, prevent acetylcholine breakdown by inhibiting the enzyme acetylcholinesterase. Dialkyl phosphates themselves are not considered toxic but rather are markers of exposure to organophosphates. Dialkyl phosphates may also be present in the environment from degradation of organophosphates. Generally recognized guidelines for urinary levels of these metabolites have not been established.

About 75% of registered organophosphate pesticides will metabolize to measureable dialkyl phosphate metabolites (U.S. EPA*b*). This *Report* provides measurements in urine for the following six metabolites of organophosphate pesticides:
- Dimethylphosphate (DMP)
- Dimethylthiophosphate (DMTP)
- Dimethyldithiophosphate (DMDTP)
- Diethylphosphate (DEP)
- Diethylthiophosphate (DEPT)
- Diethyldithiophosphate (DEDTP)

Table 131 shows the six urinary metabolites and their parent organophosphate pesticides. For example, chlorpyrifos metabolizes to both diethylphosphate and diethythiophosphate. Measurement of these metabolites reflects exposure to organophosphate pesticides that has occurred predominantly in the last few days. Each of the six urinary dialkyl phosphate metabolites can be produced from the metabolism of more than one organophosphate pesticide. In addition to reflecting exposure to the parent pesticides, the level of the metabolite in a person's urine may reflect exposure to the metabolite itself, if it was present in the person's environment.

Interpreting Urine Organophosphate Metabolite Levels Reported in the Tables

Urine levels of the dialkyl phosphate metabolites were measured in a subsample of NHANES participants aged 6 years and older. Subsamples were randomly selected within the specified age range to be a representative sample of the U.S. population. Levels of the six dialkyl phosphates reported may result from exposure to a variety of organophosphate pesticides (see Table 131). Measurements of the urinary dialkyl phosphates (Tables 132-143) provide an estimate of exposure to various classes of these organophosphate pesticides; however, without additional information, linking these metabolites to specific pesticides is not possible. These data provide physicians with a reference range so that they can determine whether people have been exposed to higher levels of organophosphate pesticides than those found in the general population. These data will help scientists plan and conduct research about exposure to organophosphate pesticides and health effects. Finding a measurable amount of one or more metabolites in urine does not mean that the level of the organophosphate(s) causes an adverse health effect. Whether organophosphate pesticides at the levels of the metabolites reported here are a cause for health concern is not known; more research is needed.

The measurement of dialkyl phosphates in urine has been used to document exposure of farmers, agricultural workers, pest-control workers, and others exposed to organophosphorus pesticides (Jauhiainen et al., 1992; Das et al., 1983; Davies and Peterson, 1997; Davies et

al., 1982; Franklin et al., 1981; Takamiya, 1994; Bro-kopp, 1981; Morgan et al., 1977; Richter et al., 1992). In such occupational studies, levels of dialkyl phosphates often exceed levels seen in the general population by up to 50-fold. Generally, in workers, doses of the parent organophosphate pesticide have been shown to correlate with the urinary excretion of the dialkyl phosphate metabolites (Lauwerys and Hoet, 2001). Dialkyl phosphate metabolites can be present in urine following low-level organophosphate exposures that do not cause clinical symptoms (Davies and Peterson, 1997; Franklin et al., 1981).

Aprea et al. (1996) studied 124 people near Tuscany, Italy, and found that DMTP and DMP were the most frequently detected alkyl phosphates (99% and 87%, respectively). The geometric mean concentration for DMTP was sevenfold higher in the Italian study than the geometric mean of the NHANES 1999-2000 subsample.

Geometric mean levels of the demographic groups were compared after adjustment for the covariates of race/ethnicity, age, gender, and urinary creatinine. Urinary diethylphosphate and dimethylthiophosphate levels in the group aged 6-11 years were higher than in the group aged 20 years and older. There were no other

Table 131. Organophosphate pesticides and their metabolites

Pesticide (CAS number)	Dimethyl-phosphate (813-79-5)	Dimethylthio-phosphate (1112-38-5)	Dimethyldithio-phosphate (756-80-9)	Diethyl-phosphate (598-02-7)	Diethylthio-phosphate (2465-65-8)	Diethyldithio-phosphate (298-06-6)
Azinphos methyl	●	●	●			
Chlorethoxyphos				●	●	
Chlorpyrifos				●	●	
Chlorpyrifos methyl	●	●				
Coumaphos				●	●	
Dichlorvos (DDVP)	●					
Diazinon				●	●	
Dicrotophos	●					
Dimethoate	●		●			
Disulfoton				●	●	●
Ethion				●	●	●
Fenitrothion	●	●				
Fenthion	●	●				
Isazaphos-methyl	●	●				
Malathion	●	●	●			
Methidathion	●	●	●			
Methyl parathion	●	●				
Naled	●					
Oxydemeton-methyl	●	●				
Parathion				●	●	
Phorate				●	●	●
Phosmet	●	●	●			
Pirimiphos-methyl	●	●				
Sulfotepp				●	●	
Temephos	●	●				
Terbufos				●	●	●
Tetrachlorviphos	●					
Trichlorfon	●					

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differences noted for race/ethnicity or gender. In a study of 195 Italian children aged 6-7 years, Aprea et al. (2000) detected levels of DMTP in 94% of the children, and the geometric mean was about five times higher than for the NHANES 1999-2000 subsample in children aged 6-11 years. In addition, these investigators noted that levels in children were higher than in adults living in the same region of Italy.

Table 132. Dimethylphosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	.740 (<LOD-1.30)	2.80 (2.10-3.90)	7.90 (5.90-9.50)	13.0 (9.50-21.0)	1949
Age group								
6-11 years	*	< LOD	< LOD	1.00 (.590-2.00)	4.40 (2.90-6.80)	10.0 (6.60-18.0)	21.0 (10.0-41.0)	471
12-19 years	*	< LOD	< LOD	.650 (<LOD-1.50)	3.80 (2.40-5.50)	9.90 (6.10-18.0)	22.0 (12.0-29.0)	664
20-59 years	*	< LOD	< LOD	.680 (<LOD-1.20)	2.60 (1.80-3.60)	6.50 (5.20-8.80)	9.70 (8.50-16.0)	814
Gender								
Males	*	< LOD	< LOD	.650 (<LOD-1.20)	2.80 (2.10-4.10)	7.90 (5.90-10.0)	18.0 (9.00-25.0)	952
Females	*	< LOD	< LOD	.780 (<LOD-1.40)	2.80 (2.00-4.00)	7.60 (5.40-9.50)	10.0 (8.50-15.0)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	1.00 (<LOD-1.60)	3.80 (2.70-4.70)	9.50 (6.80-13.0)	15.0 (10.0-23.0)	672
Non-Hispanic blacks	*	< LOD	< LOD	.980 (.650-1.30)	3.60 (2.40-5.50)	8.90 (6.50-15.0)	21.0 (12.0-24.0)	509
Non-Hispanic whites	*	< LOD	< LOD	< LOD	2.90 (1.80-4.20)	7.90 (5.50-9.60)	10.0 (8.90-21.0)	594

< LOD means less than the limit of detection, which is 0.58 µg/L.

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 133. Dimethylphosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in μg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	.806 (.586-1.11)	2.93 (2.12-3.86)	8.46 (6.74-11.2)	16.1 (12.1-19.5)	1949
Age group								
6-11 years	*	< LOD	< LOD	1.38 (.889-2.38)	4.48 (2.63-8.20)	15.9 (7.65-21.7)	21.7 (16.7-45.1)	471
12-19 years	*	< LOD	< LOD	.586 (.451-.949)	2.27 (1.67-2.91)	7.70 (4.16-13.8)	14.5 (7.78-35.3)	664
20-59 years	*	< LOD	< LOD	.759 (.562-1.11)	2.87 (1.91-3.92)	8.11 (5.45-10.6)	14.6 (10.1-17.6)	814
Gender								
Males	*	< LOD	< LOD	.623 (.453-.886)	2.38 (1.78-3.23)	7.58 (4.64-11.6)	15.2 (9.74-19.5)	952
Females	*	< LOD	< LOD	1.00 (.677-1.50)	3.53 (2.35-5.00)	9.12 (7.59-12.2)	16.4 (10.4-21.4)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	1.06 (.722-1.47)	3.68 (2.77-4.67)	9.41 (7.24-12.2)	15.9 (12.7-23.2)	672
Non-Hispanic blacks	*	< LOD	< LOD	.686 (.527-1.06)	2.67 (1.78-3.87)	7.07 (4.77-11.5)	13.9 (9.61-19.5)	509
Non-Hispanic whites	*	< LOD	< LOD	< LOD	3.15 (2.03-4.26)	8.73 (6.12-12.8)	15.8 (10.2-19.7)	594

< LOD means less than the limit of detection (see previous table).

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 134. Dimethylthiophosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	1.82 (1.43-2.32)	< LOD	< LOD	2.70 (1.50-3.80)	10.0 (8.00-16.0)	38.0 (21.0-38.0)	46.0 (38.0-60.0)	1948
Age group								
6-11 years	2.72 (1.85-4.01)	< LOD	< LOD	4.10 (2.30-7.60)	20.0 (13.0-30.0)	40.0 (38.0-54.0)	62.0 (38.0-110)	471
12-19 years	2.53 (1.72-3.73)	< LOD	< LOD	3.60 (1.70-6.00)	16.0 (8.80-24.0)	37.0 (21.0-38.0)	69.0 (39.0-190)	664
20-59 years	1.59 (1.25-2.03)	< LOD	< LOD	2.20 (1.10-3.40)	9.10 (7.10-13.0)	38.0 (18.0-38.0)	38.0 (38.0-48.0)	813
Gender								
Males	2.10 (1.58-2.78)	< LOD	< LOD	3.40 (2.40-4.50)	13.0 (8.50-20.0)	38.0 (17.0-38.0)	41.0 (38.0-62.0)	952
Females	1.59 (1.20-2.11)	< LOD	< LOD	2.00 (.720-3.30)	9.70 (6.70-16.0)	38.0 (19.0-38.0)	52.0 (38.0-120)	996
Race/ethnicity								
Mexican Americans	1.79 (1.11-2.90)	< LOD	< LOD	2.00 (.600-4.30)	10.0 (6.60-16.0)	38.0 (26.0-79.0)	130 (41.0-230)	671
Non-Hispanic blacks	2.13 (1.38-3.28)	< LOD	< LOD	3.60 (1.60-5.60)	11.0 (8.30-18.0)	37.0 (25.0-38.0)	39.0 (38.0-88.0)	509
Non-Hispanic whites	1.77 (1.30-2.39)	< LOD	< LOD	2.60 (1.10-4.00)	10.0 (7.00-17.0)	37.0 (15.0-38.0)	45.0 (38.0-62.0)	594

< LOD means less than the limit of detection, which is 0.18 µg/L.

Table 135. Dimethylthiophosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	1.64 (1.27-2.10)	< LOD	< LOD	2.12 (1.38-3.11)	9.57 (6.67-15.1)	32.0 (23.9-40.4)	51.0 (39.0-71.1)	1948
Age group								
6-11 years	2.95 (2.00-4.34)	< LOD	< LOD	5.25 (2.50-7.03)	18.7 (11.6-31.5)	45.2 (32.1-60.3)	65.9 (50.7-100)	471
12-19 years	1.71 (1.13-2.59)	< LOD	< LOD	2.14 (1.22-4.13)	13.4 (7.01-21.0)	36.0 (25.1-51.4)	61.5 (37.1-179)	664
20-59 years	1.47 (1.14-1.90)	< LOD	< LOD	1.90 (1.00-2.83)	8.09 (5.58-12.4)	27.0 (20.6-37.1)	47.4 (34.2-70.1)	813
Gender								
Males	1.61 (1.19-2.18)	< LOD	< LOD	2.28 (1.42-3.35)	9.27 (6.43-15.4)	28.9 (20.5-37.6)	41.1 (32.0-57.1)	952
Females	1.66 (1.24-2.21)	< LOD	< LOD	2.01 (.920-3.11)	10.0 (6.20-17.5)	34.5 (25.4-47.4)	69.5 (41.7-118)	996
Race/ethnicity								
Mexican Americans	1.60 (.962-2.67)	< LOD	< LOD	1.83 (.737-3.75)	10.4 (5.93-17.1)	37.0 (22.8-63.1)	112 (38.5-207)	671
Non-Hispanic blacks	1.45 (.948-2.23)	< LOD	< LOD	1.75 (1.01-3.38)	8.21 (4.65-12.4)	25.5 (17.9-38.8)	52.1 (25.5-97.6)	509
Non-Hispanic whites	1.68 (1.21-2.32)	< LOD	< LOD	2.20 (1.17-3.42)	9.27 (5.96-16.9)	32.5 (21.3-49.4)	54.4 (39.2-74.7)	594

< LOD means less than the limit of detection (see previous table).

Table 136. Dimethyldithiophosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	< LOD	2.30 (1.40-3.60)	12.0 (5.40-17.0)	19.0 (17.0-37.0)	1949
Age group								
6-11 years	*	< LOD	< LOD	< LOD	4.30 (2.50-6.90)	16.0 (5.90-18.0)	32.0 (18.0-38.0)	471
12-19 years	*	< LOD	< LOD	< LOD	2.20 (1.30-4.50)	12.0 (6.20-17.0)	19.0 (12.0-52.0)	664
20-59 years	*	< LOD	< LOD	< LOD	2.10 (1.10-3.10)	10.0 (4.20-17.0)	16.0 (6.30-19.0)	814
Gender								
Males	*	< LOD	< LOD	< LOD	2.30 (1.30-4.30)	16.0 (5.80-17.0)	18.0 (17.0-32.0)	952
Females	*	< LOD	< LOD	< LOD	2.10 (1.30-3.20)	10.0 (4.50-17.0)	20.0 (13.0-40.0)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	< LOD	1.80 (1.20-2.30)	5.70 (4.00-9.70)	12.0 (6.80-17.0)	672
Non-Hispanic blacks	*	< LOD	< LOD	< LOD	3.20 (1.70-6.50)	14.0 (7.00-18.0)	18.0 (17.0-39.0)	509
Non-Hispanic whites	*	< LOD	< LOD	< LOD	2.00 (.850-3.70)	13.0 (4.20-17.0)	18.0 (16.0-40.0)	594

< LOD means less than the limit of detection, which is 0.08 µg/L.

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 137. Dimethyldithiophosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	< LOD	1.86 (1.04-3.25)	10.1 (5.63-16.6)	21.7 (13.8-30.8)	1949
Age group								
6-11 years	*	< LOD	< LOD	< LOD	4.07 (2.34-7.00)	16.2 (9.25-27.0)	30.8 (20.2-38.9)	471
12-19 years	*	< LOD	< LOD	< LOD	1.52 (.636-3.37)	9.42 (4.02-16.8)	18.5 (8.76-44.8)	664
20-59 years	*	< LOD	< LOD	< LOD	1.71 (.920-2.82)	8.46 (4.96-16.6)	19.2 (9.82-35.2)	814
Gender								
Males	*	< LOD	< LOD	< LOD	1.64 (.870-3.45)	11.0 (5.32-16.6)	17.8 (10.1-34.2)	952
Females	*	< LOD	< LOD	< LOD	1.99 (1.00-3.67)	9.30 (5.41-21.5)	27.0 (9.82-47.5)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	< LOD	1.35 (.968-1.99)	6.55 (4.10-11.6)	16.7 (6.94-34.2)	672
Non-Hispanic blacks	*	< LOD	< LOD	< LOD	2.39 (1.18-4.53)	9.41 (5.11-16.6)	17.8 (11.6-36.0)	509
Non-Hispanic whites	*	< LOD	< LOD	< LOD	1.75 (.847-4.00)	11.3 (4.79-20.2)	21.5 (12.8-30.8)	594

< LOD means less than the limit of detection (see previous table).

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 138. Diethylphosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	1.03 (.757-1.40)	< LOD	< LOD	1.20 (.800-1.50)	3.10 (2.40-4.60)	7.50 (5.20-11.0)	13.0 (8.00-21.0)	1949
Age group								
6-11 years	1.32 (.846-2.05)	< LOD	< LOD	1.40 (.990-2.10)	4.50 (2.30-6.50)	10.0 (4.80-16.0)	15.0 (11.0-27.0)	471
12-19 years	1.21 (.852-1.72)	< LOD	< LOD	1.30 (1.00-1.90)	3.70 (2.40-5.40)	7.90 (4.20-23.0)	20.0 (8.00-27.0)	664
20-59 years	.955 (.701-1.30)	< LOD	< LOD	1.00 (.730-1.40)	3.00 (2.10-4.40)	7.20 (4.90-10.0)	10.0 (6.90-19.0)	814
Gender								
Males	1.11 (.807-1.54)	< LOD	< LOD	1.10 (.850-1.40)	3.80 (2.50-4.90)	8.00 (5.00-19.0)	18.0 (7.40-27.0)	952
Females	.954 (.692-1.32)	< LOD	< LOD	1.10 (.730-1.50)	2.90 (2.10-4.40)	7.50 (4.90-10.0)	11.0 (7.70-14.0)	997
Race/ethnicity								
Mexican Americans	1.22 (.869-1.71)	< LOD	< LOD	1.10 (.840-1.50)	4.10 (2.60-6.40)	11.0 (6.90-13.0)	17.0 (12.0-23.0)	672
Non-Hispanic blacks	1.56 (1.23-1.98)	< LOD	< LOD	1.60 (1.30-1.80)	4.20 (2.90-5.80)	10.0 (6.20-16.0)	18.0 (10.0-26.0)	509
Non-Hispanic whites	.980 (.666-1.44)	< LOD	< LOD	1.10 (.580-1.50)	3.30 (2.30-4.90)	7.60 (4.80-14.0)	14.0 (7.90-23.0)	594

< LOD means less than the limit of detection, which is 0.2 µg/L.

Table 139. Diethylphosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	.924 (.687-1.24)	< LOD	< LOD	.924 (.632-1.28)	2.73 (1.89-4.29)	7.94 (4.90-11.7)	12.1 (8.75-17.5)	1949
Age group								
6-11 years	1.43 (.940-2.16)	< LOD	< LOD	1.47 (1.02-2.41)	3.94 (2.39-8.15)	10.3 (4.55-20.6)	16.2 (10.5-32.7)	471
12-19 years	.818 (.588-1.14)	< LOD	< LOD	.786 (.622-1.13)	2.29 (1.40-3.42)	5.38 (2.89-12.3)	12.3 (4.87-23.8)	664
20-59 years	.883 (.649-1.20)	< LOD	< LOD	.857 (.583-1.18)	2.63 (1.71-4.38)	7.37 (4.60-11.3)	12.1 (8.57-15.7)	814
Gender								
Males	.855 (.626-1.17)	< LOD	< LOD	.811 (.593-1.19)	2.61 (1.76-4.13)	7.69 (4.55-11.7)	12.2 (8.00-21.6)	952
Females	.996 (.729-1.36)	< LOD	< LOD	.956 (.636-1.45)	2.80 (1.89-4.72)	8.00 (4.90-11.7)	12.1 (8.10-17.5)	997
Race/ethnicity								
Mexican Americans	1.09 (.753-1.58)	< LOD	< LOD	1.05 (.737-1.57)	3.78 (2.29-5.79)	9.84 (6.57-14.4)	15.6 (10.3-19.3)	672
Non-Hispanic blacks	1.07 (.836-1.36)	< LOD	< LOD	1.17 (.833-1.53)	2.55 (2.13-3.24)	5.98 (4.22-8.93)	11.7 (6.62-19.4)	509
Non-Hispanic whites	.931 (.639-1.36)	< LOD	< LOD	.900 (.505-1.48)	2.82 (1.75-5.33)	8.46 (4.95-13.3)	12.6 (8.89-19.6)	594

< LOD means less than the limit of detection (see previous table).

Table 140. Diethylthiophosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	.490 (<LOD-.620)	.760 (.660-.910)	1.30 (1.20-1.60)	2.20 (1.70-2.80)	1949
Age group								
6-11 years	*	< LOD	< LOD	.590 (<LOD-.720)	.900 (.730-1.20)	1.70 (1.30-2.40)	3.13 (1.70-5.00)	471
12-19 years	*	< LOD	< LOD	.210 (<LOD-.640)	.780 (.630-1.20)	1.40 (1.20-1.90)	2.20 (1.60-3.10)	664
20-59 years	*	< LOD	< LOD	.480 (<LOD-.590)	.740 (.630-.910)	1.30 (.990-1.50)	2.00 (1.50-2.80)	814
Gender								
Males	*	< LOD	< LOD	.500 (<LOD-.630)	.790 (.700-1.00)	1.40 (1.20-1.90)	2.70 (1.90-4.10)	952
Females	*	< LOD	< LOD	< LOD	.720 (.600-.910)	1.24 (.950-1.50)	1.70 (1.30-2.70)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	.560 (<LOD-.700)	.840 (.740-.980)	1.40 (1.10-1.90)	2.20 (1.90-2.90)	672
Non-Hispanic blacks	*	< LOD	< LOD	.560 (<LOD-.670)	.810 (.690-1.20)	1.80 (1.24-3.30)	3.50 (1.80-4.80)	509
Non-Hispanic whites	*	< LOD	< LOD	.160 (<LOD-.630)	.730 (.600-1.00)	1.30 (.980-1.50)	1.80 (1.50-2.80)	594

< LOD means less than the limit of detection, which is 0.09 µg/L.

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 141. Diethylthiophosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	**25th**	**50th**	**75th**	**90th**	**95th**	
Total, age 6-59	*	< LOD	< LOD	.254 (.102-.417)	.706 (.511-.957)	1.70 (1.21-2.17)	2.64 (2.12-2.96)	1949
Age group								
6-11 years	*	< LOD	< LOD	.470 (.146-.827)	1.08 (.827-1.30)	1.73 (1.44-2.36)	2.45 (1.88-5.42)	471
12-19 years	*	< LOD	< LOD	.176 (.061-.330)	.509 (.335-.761)	1.07 (.777-1.53)	1.97 (1.07-3.92)	664
20-59 years	*	< LOD	< LOD	.250 (.102-.409)	.685 (.467-.958)	1.79 (1.18-2.32)	2.75 (2.12-3.06)	814
Gender								
Males	*	< LOD	< LOD	.267 (.100-.415)	.672 (.521-.809)	1.34 (1.08-2.18)	2.66 (1.56-3.23)	952
Females	*	< LOD	< LOD	< LOD	.790 (.452-1.20)	1.89 (1.22-2.33)	2.52 (2.08-2.96)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	.335 (.097-.567)	.829 (.567-1.13)	1.69 (1.30-2.16)	2.71 (1.86-3.55)	672
Non-Hispanic blacks	*	< LOD	< LOD	.300 (.153-.463)	.717 (.539-.838)	1.35 (.902-2.89)	2.89 (1.35-5.13)	509
Non-Hispanic whites	*	< LOD	< LOD	.230 (.081-.456)	.705 (.462-1.05)	1.88 (1.20-2.36)	2.58 (2.12-2.96)	594

< LOD means less than the limit of detection (see previous table).

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 142. Diethyldithiophosphate

Geometric mean and selected percentiles of urine concentrations (in µg/L) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	.080 (<LOD-.110)	.200 (.150-.290)	.470 (.390-.630)	.870 (.650-1.00)	1949
Age group								
6-11 years	*	< LOD	< LOD	.080 (<LOD-.110)	.190 (.150-.240)	.430 (.300-.550)	.850 (.490-1.00)	471
12-19 years	*	< LOD	< LOD	.080 (<LOD-.110)	.260 (.120-.350)	.640 (.360-.860)	.900 (.680-1.30)	664
20-59 years	*	< LOD	< LOD	.080 (<LOD-.110)	.210 (.130-.290)	.450 (.360-.620)	.900 (.610-1.10)	814
Gender								
Males	*	< LOD	< LOD	.090 (<LOD-.110)	.220 (.160-.290)	.470 (.360-.660)	.870 (.650-1.10)	952
Females	*	< LOD	< LOD	.080 (<LOD-.100)	.190 (.110-.300)	.450 (.350-.690)	.850 (.460-1.40)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	.100 (.070-.150)	.310 (.230-.390)	.650 (.490-1.00)	1.10 (.630-1.70)	672
Non-Hispanic blacks	*	< LOD	< LOD	.090 (<LOD-.100)	.270 (.180-.330)	.560 (.420-.820)	.850 (.650-1.20)	509
Non-Hispanic whites	*	< LOD	< LOD	.080 (<LOD-.120)	.190 (.120-.280)	.420 (.320-.680)	.870 (.510-1.10)	594

< LOD means less than the limit of detection, which is 0.05 µg/L.

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

Table 143. Diethyldithiophosphate (creatinine adjusted)

Geometric mean and selected percentiles of urine concentrations (in µg/gram of creatinine) for the U.S. population aged 6 to 59 years, National Health and Nutrition Examination Survey, 1999-2000.

	Geometric mean (95% conf. interval)	Selected percentiles (95% confidence interval)						Sample size
		10th	25th	50th	75th	90th	95th	
Total, age 6-59	*	< LOD	< LOD	.074 (.057-.105)	.196 (.152-.264)	.549 (.407-.692)	.859 (.692-1.13)	1949
Age group								
6-11 years	*	< LOD	< LOD	.102 (.069-.133)	.193 (.154-.250)	.571 (.385-.797)	1.03 (.596-1.57)	471
12-19 years	*	< LOD	< LOD	.051 (.039-.074)	.167 (.098-.222)	.435 (.229-.731)	.731 (.385-.948)	664
20-59 years	*	< LOD	< LOD	.075 (.057-.108)	.205 (.148-.293)	.549 (.380-.714)	.859 (.667-1.16)	814
Gender								
Males	*	< LOD	< LOD	.066 (.046-.100)	.186 (.139-.222)	.415 (.317-.524)	.719 (.486-.938)	952
Females	*	< LOD	< LOD	.087 (.059-.117)	.219 (.156-.321)	.667 (.411-.861)	.886 (.707-1.38)	997
Race/ethnicity								
Mexican Americans	*	< LOD	< LOD	.094 (.068-.150)	.302 (.192-.407)	.812 (.517-1.00)	1.16 (.859-2.66)	672
Non-Hispanic blacks	*	< LOD	< LOD	.067 (.048-.103)	.175 (.131-.223)	.450 (.283-.675)	.692 (.481-1.07)	509
Non-Hispanic whites	*	< LOD	< LOD	.074 (.053-.108)	.204 (.143-.286)	.554 (.386-.731)	.875 (.654-1.16)	594

< LOD means less than the limit of detection (see previous table).

* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.